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Abstract: Planted forests are increasingly recognised for the provision of habitats for species threatened with extinction. Despite this development, a limited number of empirical studies have been undertaken to estimate the economic value of this ecosystem service. New Zealand's planted forests provide habitat to at least 118 threatened species. These forests can be managed to increase the abundance of many of these species. We present findings from survey data obtained in a discrete choice experiment designed to estimate the non-market values for a proposed biodiversity enhancement programme in New Zealand's planted forests. We used a two-stage modelling process. First we estimated the individual specific willingness to pay values and then we explored their socio-economic and spatial determinants. The first stage modeling process, which used a random parameters logit model with error components, suggested that willingness to pay was higher for increasing the abundance of native bird than for non-bird species. The second stage model used a least squares panel random-effects regression. Results from this method suggested that socioeconomic characteristics, such as attitudes toward the programme and distance from large planted forests, influenced willingness to pay for biodiversity enhancement.

We would like to thank Reviewers 2 and 3 for their additional comments that helped improved the quality of this manuscript. Our responses to their comments are in *italics* below.

Reviewers' comments:

Reviewer #2: Based on the second revision I would now suggest the manuscript for publication; I have just two minor points:
1) You may check whether all references you make are really essential; e.g., concerning the experimental design you have in line 232 in total 7 references. Given the length of the manuscript and as design criteria are not really your topic please consider to reduce the references to those that are really essential for your work

Thank you for this comment. References now reduced to 2.

2) Again, I would not insist on dropping the RPL model without error component (Table 3) - and thus I haven't mentioned this in my reply to the former revision - but I still agree with reviewer 3 that this model does not add much to your paper and for the sake of brevity I think you can drop Model 2 and Model B in Table 5, but the arguments you present in favour of these models are not convincing. Thus, you might think again dropping this and adjust the section about model descriptions - less is often more! :)

Thank you for this comment. We have now dropped Models 1 and 2 and also Models A and B. We agree with yours and Reviewer 3's comments. Dropping those models makes the paper shorter and more focused on key findings.

Reviewer #3: Review of ECOLEC-D-12-00597R2 This manuscript has improved considerably and I believe that the authors have adequately handled most comments. However, there are still some remaining issues which mainly concern presentation as well as some justification and reference issues in the minor comments.

1. I reiterate that there is nothing special about a mixed model that contains both a random parameter for the attributes and for the status quo effect/constant (i.e. an error component). This is just a mixed logit model; the paper does not provide any methodological contribution in this respect, it does not deserve so much text or a keyword. The manuscript could be considerably shortened by just including the mixed logit model; i.e. combining sections 3.1 and 3.2, and reducing the results section and table. Simple MNL models are far below the standards of this journal (which publishes mixed logit models regularly and also more advanced methods such as models in WTP-space), and there is nothing to be learned from Models 1 and 2 - any reader should immediately ignore them.

Thank you for this comment. We now combined sections 3.1 and 3.2, and also dropped Models 1 and 2. This resulted to a significant reduction in text. It also allowed us to drop an equation. By reporting only Model 3 in the results section, the paper has become succinct and easier to follow.

In the set of keywords, we changed "random parameters logit with error components" to "random parameters logit model"

2. Similarly, the manuscript could be easily shortened by just including Model C. There is nothing to be learned from Model A and B when C is included. The authors want to focus on spatial attributes (see title) so that the inclusion of models A and B without spatial variables is taking the attention of the reader away from the main message of the paper.

Especially since the results on the spatial variables are rather weak, there is no reason why the reader has to go through three fairly similar models A, B and C.

Thank you for this comment. We now only report Model C and dropped Models A and B. This significantly reduced the amount of text.

3. The authors should pay careful attention to the notation. In equation 1, the k is not explained. Then, in footnote 7, they talk about subscripts ijs, where i possibly reflects an individual (for which an n was used in equation 1). It is confusing that the authors use c1 and c2 here, where they used j before.

Thank you for pointing out this inaccuracy. Because we have combined sections 3.1 and 3.2 as suggested in your previous comment, the equation with c1 and c2 subscripts is no longer needed.

4. In the model results table 3, the authors should include which distribution was used for the attributes, and present the s.d. of the random parameters together with their means, so that the means and s.d. can easily be compared. Unrestricted triangulars may result in negative WTP values for the attributes; why were the distributions not restricted? Also note that there are empty brackets after 'error component', and there are still no values in italics.

Thanks for this suggestion. Table 3 is now updated. We note that the spread coefficient in the triangular distribution is not a S.D. but more appropriately a "spread" parameter. Following the advice from this reviewer, we now present the estimates for the spread parameters together with the means. Assumed distributions of random parameters now reported. Empty brackets after error component now changed to (σ_ε).

While we agree that constrained triangular distributions are often or primarily used to constrain a random coefficient's variation to a given sign or neighbourhood of values, in our case we use it for random coefficients of environmental attributes (e.g. gecko, falcon) because this choice of distribution fit the data better than alternative ones (e.g. normal and log-normal).

In the text of Footnote 7 of the revised version we have added: "We have used unrestricted triangular for the environmental attributes to allow the WTP to vary between positive and negative. For example, some people might have a negative preference for geckos which may be regarded as undesirable "creepy crawlies". Constrained triangular distributions are often or primarily used to constrain a random coefficient's variation to a given sign or neighbourhood of values. In our case, instead, we used the unconstrained triangular for the random coefficients because this choice of distribution fit the data better than alternative ones (e.g. normal and log-normal)."

5. In Table 4, the authors include a value for the status quo, but this coefficient is not significant at the 5% level.

Thanks for this comment. We have now replaced the non-significant WTP values with "NS" which means "not significant".

6. In Table 5, the standard error for all attribute levels is the same in models B and C. Is this correct? Why does the table present average log-likelihood values whilst footnote 12 discusses different ('standard' ?) log-likelihood values?

Thanks for pointing this out. We now report the "standard" log-likelihood value (instead of "average" log-likelihood) for Model C. We dropped Models A and B and reported only Model C estimates, based on your advice.

Minor changes:

1. The authors should include what respondents were told to suggest consequentiality (rather than including a sentence that the survey text induced consequentiality - line 219-220).

Thanks for this comment. Appendix A now is added and reports the script seen by the respondents.

Footnote 3 does not address the issue raised in my comment.

The sentence in Footnote 3 (now Footnote 2 of the revised version) is now changed to

"We chose income tax because biodiversity conservation is a pure public good and as such it should be funded by the central government. We realize that in our sample the fraction of respondents not income paying taxes is higher than the NZ average. We assume that for most this is only a temporary and not a permanent condition over the five year period that the payment is hypothesized for. As such the incentive compatibility of this payment vehicle should not have been seriously affected."

2. The authors should include references in the text that suggest that combining different types of designs can be done without compromising the modelling results.

Thank you for pointing this out. To address your comment above, we have added a paragraph in Lines 248 to 255 where we wrote:

"In splitting the sample by design, we did not find significant differences in WTP estimates. To the best of our knowledge, there is no study yet that examines the impact of using a combination of the experimental designs used in this study. However, we can assume that the impact of using such mixture of designs on the estimates would be minimal because each design might tend to offset its impact on the other given the difference in optimisation criterion (e.g. Bayesian D-efficiency, orthogonality). Perhaps a future study that evaluates the impacts of such mixture of designs would shed light on this issue."

3. The paragraph starting at line 408 is superfluous and largely repeats earlier paragraphs.

Thanks for this comment. We have dropped the paragraph accordingly.

4. Line 455-461. 'Government should pay' is indeed often labelled as protest-bid. See Brouwer et al. (2012, REE) for a reference to back up the choice made in this paper. Move the discussion in lines 559-562 up to line 461.

Thank you for this comment. We have now cited Brouwer and Martin-Ortega (2012) and moved up the two sentences accordingly. We included the sentences below in Lines 433 to 439 of the revised version of the manuscript.

"We asked respondents about their attitude toward supporting the proposed programme and found that 18 percent had the "Government-should-pay" attitude. This type of negative attitude is often labeled as a protest bid in the literature but it is not necessarily the case (Brouwer and Martin-Ortega 2012). Our data indicate that five percent of the respondents who selected some non-status-quo alternatives also had the "Government Should Pay" attitude for the proposed programme."

5. The low response rate should be mentioned in the discussion. In footnote 10, the statement 'this is often the case in survey research' should be backed up by a reference.

Thank you for this comment. We have now provided three examples of previous surveys with low response rates in Footnote 4 of the revised version. We included "Johnston and Roheim (2006) with 31%, Wordsworth el al. (2006) with 32%, and Chen et al. (2010) with 29%".

Footnote 10 is now Footnote 9 in the revised version. The group of words "this is often the case in survey research" refers to the larger proportion of respondents not in the labour force being higher than the national average. To provide a reference, we now cite Kaval et al. (2009) which is another stated preference survey conducted in New Zealand where a large proportion of respondents was not in the labour force (e.g., retired).

6. Line 630 onwards. Campbell et al (2007) ex post analyses the spatial correlation in errors from a CE. Schaafsma et al. (2012) included both distance and socio-demographic characteristics in the WTP function (not separately!).

Thanks for your comment. The text has now been updated (in Lines 578 to 579) to:

"(e.g., Campbell, 2007 – socioeconomic effects; Schaafsma, 2012 – socio-demographic characteristics and directional distance effects)"

Typos/grammar/language

* Line 3. change 'very limited empirical studies' into 'a limited number of empirical studies'

Done.

* Line 5. change 'habitats' into 'habitat'

Done.

* Line 6. Remove 'specifically'

Done.

* Line 44/onwards. Abbreviate 'contingent valuation' where it first appears and use the abbreviation from that point onwards.

Done.

* Line 50/onwards. Abbreviate 'choice experiment' where it first appears and use the abbreviation from that point onwards. SP, CV and CE are standard abbreviations for this journal. Also, both in line 176 and line 88 you introduce this abbreviation!
Done.

* Line 50. Insert [a] in line 50 before 'choice experiment'
Done.

* Line 57/onwards. Abbreviate 'stated preference' where it first appears and use the abbreviation from that point onwards.
Done.

* Line 57. Choice experiment should be plural in this sentence (in brackets)
Now in "plural form".

* Line 72. Use the abbreviation for WTP (see line 68)
Changed "Willingness to pay" to "The WTP"

* Line 77-87. This discussion can be abbreviated by stating that forests and biodiversity may have existence and bequest values. Lines 77-78 and 82-83 are fairly repetitive.
Paragraph now made succinct.

* Footnote 1, page 4. Insert the footnote about the brown kiwi where the brown kiwi is first mentioned. On page 4 it is confusing; it would probably fit better where the attributes are explained and the expectations regarding their parameters are
Footnote now transferred to where brown kiwi is mentioned as one of the attributes.

* Line 140. change 'shows' into 'show'
Changed accordingly.

* Line 158. remove 'sets of'
Removed.

* Line 162. remove '/'
Removed.

* Line 169. Insert 'the' before 'sampling approach' and 'construction'.
'the' now added.

* Line 185. Remove three; CEs can have two or more alternatives, not necessarily three.
'three' changed to 'two or more'

* Line 192. Remove 'delivering that specific alternative'.
Removed.

* Line 328. replace 'wrong' by 'theoretically invalid' or 'theoretically unexpected'
"wrong" now changed to "theoretically invalid"

* Line 330. what does 'taste intensities' mean; just attribute coefficients?
"(or attribute coefficients)" added.

* Line 465. insert 'a' before 'contiguous'?
'a' now added

* Line 520. replace '/' by 'and'.
'/' now changed to 'and'

* Footnote 10. Please clarify to concerned readers that 'filing income' also means that they have to pay tax, and that it is not just a bureaucratic exercise for those with no or little income.

In the footnote (now footnote 9) we have specified that:

"In New Zealand people not in the labour force (e.g. retired), still pay income taxes. Homemakers and adult students are also required to file (and if needed pay) their income taxes even when they do not have work income in that tax year. In this study, the proportion of respondents who were not in the labour force was higher than the national average. This is often the case in survey research due to the fact that the cost of time of this category of people is lower than that of those in the labour force (e.g., Kaval et al. (2009))."

* Line 554. use the abbreviation for DOC.
Abbreviated accordingly.

* Line 578. Clarify the sentence: 'A log transformation was imposed on the geo-spatial distance values to more closely meet the assumptions of the statistical inference procedure'.

Thanks for this comment. As Table 5 already shows that we used the log of forest area, we believe that the sentence above is not necessary and therefore we dropped it.

* Lines 607-609. Rephrase the sentence: 'it is obvious to us'(not to others?)

Thanks for this comment. We have now changed the sentence

"…it is obvious to us that without a measure of individual variation of WTP one cannot address the issue of what are its determinants"

to

"…it is important to have a measure of individual variation of WTP to identify its determinants."

* Line 623. Correct the reference: WBCSD (not WBSCD).
Changed accordingly

* Line 623. There is as issue with the response rate and representativeness, not necessarily with the sample size.
'Sample size' now changed to 'response rate'

* Line 627. the general public would be willing to financially support such 'an' initiative.
'an' now added.

Highlights

- Biodiversity enhancement is valued in New Zealand's exotic planted forests
- Results suggest higher WTP values for conservation of birds than for other species
- Participation in conservation groups has the greatest positive influence on WTP
- WTP values are influenced by the level of understanding of choice questions
- Close proximity to large planted forests affects WTP positively and significantly

*Title Page

Valuing Biodiversity Enhancement in New Zealand's Planted Forests: Socioeconomic and Spatial Determinants of Willingness-To-Pay [¤]

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[¤] The opinions provided in the paper have been provided in good faith and on the basis that every endeavour has been made to be accurate and not misleading and to exercise reasonable care, skill and judgement.

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Abstract

Planted forests are increasingly recognised for the provision of habitats for species threatened with extinction. Despite this development, a limited number of empirical studies have been undertaken to estimate the economic value of this ecosystem service. New Zealand's planted forests provide habitat to at least 118 threatened species. These forests can be managed to increase the abundance of many of these species. We present findings from survey data obtained in a discrete choice experiment designed to estimate the non-market values for a proposed biodiversity enhancement programme in New Zealand's planted forests. We used a two-stage modelling process. First we estimated the individual specific willingness to pay values and then we explored their socio-economic and spatial determinants. The first stage modeling process, which used a random parameters logit model with error components, suggested that willingness to pay was higher for increasing the abundance of native bird than for non-bird species. The second stage model used a least squares panel random-effects regression. Results from this method suggested that socioeconomic characteristics, such as attitudes toward the programme and distance from large planted forests, influenced willingness to pay for biodiversity enhancement.

Keywords: *planted forests, biodiversity, discrete choice experiment, willingness to pay, random parameters logit, ordinary least squares panel regression*

1. Introduction

Planted forests are defined as a type of land use “composed by trees established through planting or seeding by human intervention” by the Food and Agriculture Organisation (FAO, 2012a). The world’s 264 million hectares of planted forest account for seven percent of the global forest area (FAO, 2010). A planted forest can host a single or many natural and/or exotic forest species. Allocation of land for planted forests is generally undertaken for commercial reasons such as to address demand for roundwood, pulp, non-wood products and other forest goods (Bauhus et al., 2010). Planted forests also contribute to conservation of natural forests by off-setting pressure on primary and old growth forests (UNCED, 1992; Dyck, 2003). In addition, planted forests provide ecosystem services that include water quality improvement, carbon sequestration and habitat provision for native species (including those threatened by extinction) (Brockerhoff et al., 2008; Jukes et al., 2001; Pawson et al., 2010; Whittam et al., 2002; FAO, 2012b; Yao et al., 2013). Planted forests can be managed to enhance the provision of habitat for rare and protected native species (Bauhus et al., 2010; Maunder et al., 2005; Pawson, 2005), but these benefits come at a cost (Alavalapati et al., 2002; Matta et al., 2009; Weir, 2010). Such benefits are difficult to define and to quantify. It is therefore important to examine if the general public would benefit, and by how much, from a biodiversity enhancement initiative. This study sets out to achieve this by conducting a nationwide choice experiment survey.

1.1 Previous studies

Many studies have explored the links between forests, their biodiversity and the benefits derived from such biodiversity by the general public. Of these studies, some have examined how biodiversity enhancement affects the value derived by an individual from forest recreation. For example, Scarpa et al. (2000) applied contingent valuation (CV) and found that creating nature reserves in forests in Ireland, which contributes to preserving biodiversity, was significantly and positively associated with the economic welfare of forest visitors. This result is consistent with other empirical studies that also suggest forest biodiversity enhancement positively affects recreational choice; forests with higher levels of species diversity are preferred to those with lesser diversity (Boxall et al., 1996a; Hanley et al., 2002; Dhakal et al, 2012). Boxall and Macnab (2000) used a choice experiment (CE) and found that increasing the opportunity to see rare wildlife species in Canadian boreal forests was of significant additional value to wildlife viewers. Christie et al. (2007) employed a series of stated "choice experiments" alongside contingent behaviour methods and found that cyclists, horse riders, nature watchers and general forest recreationists would be willing to pay up to £19 per person per visit to support a proposed programme that would increase the opportunities to view wildlife in United Kingdom woodlands.

One criticism of the stated preference (SP) approach (which includes CE) is that it is based on a hypothetical market and respondents may deal with unfamiliar situations (Whitehead et al., 2011). For this reason, the development of a hypothetical market for the non-market good in question requires a rigorous scoping exercise prior to conducting the experiment. This exercise involves interviewing experts and conducting in-depth focus groups to objectively identify the attributes and carefully construct the valuation scenario. Although the market is hypothetical, the change in provision from the status-quo conditions to an improved level should be both ecologically feasible and perceived as realistic by respondents. The inclusion of cheap talk scripts, such as those developed by Cummings and Taylor (1999), has also been found to reduce hypothetical bias (Landry and List 2007; Mozumder and Berrens 2007). In terms of estimation of willingness to pay

(WTP) values, Axsen et al. (2009) combined SP data with revealed preference (RP) data and estimated a model that imposes a greater weight on the SP data. They found this approach to produce more realistic WTP values as RP data tend to suffer from the econometric problem of multicollinearity.

The WTP for viewing or hearing forest wildlife species mainly applies to on-site forest users. In addition, some members of the general public would still be willing to pay for a biodiversity enhancement programme even though they are unlikely to visit forests. Some planted forests in New Zealand are situated on leased private land and public access to these is limited. However, even individuals who may not have access to the forest may still hold positive existence values (values placed on the existence of a resource) and bequest values (values from endowing biodiversity for future generations) for forest biodiversity (Meyerhoff et al., 2009; Garrod and Willis 1997; Sutherland and Walsh, 1985; Freeman, 1993). In general, initiatives to conserve or enhance the abundance of species that are threatened by extinction are valued by the general public even when those who support these initiatives do not necessarily directly experience the outcomes (Meyerhoff et al., 2009).

Recent CE based environmental valuation studies have been linked primarily to ecosystem services. For instance, Tait et al. (2012) used CE data and a random parameters logit model to value water quality and quantity in the Canterbury region in New Zealand. Morse-Jones et al. (2012) applied CE to investigate the preferences of UK residents for conservation of charismatic and endemic species in Tanzania. Christie et al. (2006) used CE to examine a range of biodiversity policy attributes including familiarity of species, species rarity, habitat, and ecosystem processes. Travisi and Nijkamp (2008) used CE to examine if respondents would pay a premium price for agricultural products produced in environmentally benign ways, partly to conserve biodiversity in farmland ecosystems. This present study aims to extend these previous ecosystem valuation studies by using CE to examine the preferences of a sample of respondents toward improved habitat provision for key species in planted forests. Although planted forests in New Zealand are highly modified from their native counter-parts, they can still be managed to provide habitat for particular species. To keep our valuation scenario simple, we elected to focus on species that are likely to be familiar to respondents (e.g., brown kiwi). This study specifically focused on species abundance. Abundance is only one aspect of the complex concept of biodiversity, but an important one.

1.2 New Zealand's planted forests and biodiversity values

New Zealand has 1.72 million hectares of planted forest accounting for 22 percent of the country's total forest area (MPI, 2012). As of March 2011, planted forest products were one the country's major contributor to exports with a total value of NZ$4.7 billion (3 percent of GDP) (NZFOA, 2011). New Zealand's planted forests consist mainly of exotic tree species, with radiata pine (*Pinus radiata*) accounting for 90 percent of the total forest area, while the remaining species include Douglas-fir (*Pseudotsuga menziesii*), Cypresses (*Cupresus* spp.) and Eucalypts (*Eucalyptus* spp.) (MPI, 2012). Although these forests are intensively managed for timber production, many threatened species can still complete their life cycle in planted forest areas (Pawson et al., 2010).

Planted forests provide habitat for at least 118 threatened native species that include the brown kiwi (the country's national symbol) and the bush falcon (Seaton et al., 2009; Pawson et al., 2010). Areas in between clear-cut and remaining forest stands of the Kaingaroa forest in the Central North Island region provide bush falcon habitat that is better than any other area (Maunder, 2008; Seaton et al., 2009). The Kaingaroa forest has the highest concentration of bush falcon in the country (Stewart and Hyde, 2004). The presence of a mosaic of stands with different age profiles across this 185,000-hectare forest provides falcons with suitable nesting sites and a plentiful supply of prey (Seaton, et al., 2010; Maunder, 2008). Additional conservation activities could be undertaken with conservation groups. Such activities include increasing the frequency of monitoring of falcon nests and targeted pest control, which would help sustain and enhance falcon population in the forest (Maunder, 2008). New conservation activities would not only entail additional costs but are also likely reduce the number of trees that can be harvested, thereby reducing the sustainability of a forest business. For example, a five-year programme that could guarantee the establishment of a bush falcon population in a forest would cost approximately NZ$100,000 to undertake (Yao et al., 2012).

Native plants and animals are highly valued by New Zealanders because they contribute to the culture and a sense of national identity (DOC, 2010). Native birds and plants can be seen all over the country, both in public conservation areas (e.g., national parks, forest parks) and private lands (e.g., planted forests). Using a dichotomous choice CV method, Yao and Kaval (2010) estimated that an average New Zealand resident would be willing to pay about NZ$82 (in 2008 currency) per year in additional local taxes to support the planting of more native trees and shrubs on public land and NZ$42 per year for more native plants on private land. Planting native trees and shrubs would provide additional habitat to native fauna such as birds, fishes and geckos. Although Yao and Kaval (2010) show that additional native trees are valued on private land, it remains unclear whether increasing the abundance of threatened native species in planted forests by improving habitats would be valued by New Zealanders, and if so how much it is valued.

1.3 Research questions and structure of the paper

Adequate estimates of the benefits to New Zealanders of policies to enhance biodiversity in planted forests would provide insights and guidance to the implementation of the country's biodiversity programmes on private land. Many of these programmes are in line with New Zealand's 20-year Biodiversity Action Plan (2000 to 2020) (Ministry for the Environment, 2000a, 2000b). This action plan encourages those government agencies concerned with biodiversity to establish partnerships with the private sector (e.g., forest companies) to manage biodiversity, which includes conservation of key threatened species (Ministry for the Environment, 2000a; CAG, 2012). Estimates of the value of the benefits from biodiversity enhancement will inform the formulation of future policies for the management of planted forests not only in New Zealand but also in other countries where similar conditions exist. Rather than simply derive benefit estimates, we wish to go a step further and explore the determinants of the variation within our sample of such estimates. We aim to answer the following questions in this study:

(1) Which factors influence individual WTP for biodiversity enhancement and by how much would these factors affect the individual WTP?

(2) Would an individual residing close (i.e., less than ten kilometres away) to large planted forests have a higher WTP for biodiversity enhancement compared to those living further away?

Answers to the above questions would be useful for the planning of biodiversity on private land. For forest managers, WTP estimates can be used to report on the value of enhanced biodiversity to the local community and the trade-offs in revenues from timber production and environmental values from forest management.

Section 2 describes the different approaches used in this study to estimate biodiversity values, the sampling approach and the construction of spatial data. Section 3 describes the econometric models and spatial methods used in the study. Section 4 provides a summary of the data collected. Section 5 presents the results of econometric analyses and interpretations of the estimated coefficients. The paper ends with conclusions and policy implications.

2. Approaches to Valuing Biodiversity Enhancement

2.1 The choice experiment

CE has been conducted in the field of environmental economics since the mid-1990s (Boxall et al., 1996b) to obtain indirectly data on the preference of individuals for changes in the provision of environmental goods. In a CE survey, a respondent is presented with a series of choice tasks that leads to the collection of a panel of choice responses. Each choice task contains a set of alternatives. Each set is described by several environmental attributes of relevance to the sample of respondents and a cost for each alternative in the choice task. The choice set usually includes a *status quo* (with attribute levels set at their current levels of provision) and *experimentally designed alternatives* (with attribute levels set at current and changed levels of provisions). When a respondent selects the preferred alternative (from among two or more alternatives), she implicitly reveals her trade-offs between the levels of attributes in all the alternatives shown in a choice task. A sample choice task used in this study is given in Figure 1. In this study, each survey respondent was provided with nine choice tasks to evaluate. Each choice task had three alternatives and six attributes.

[Figure 1 goes about here]

Of the six attributes in Figure 1, five relate to environmental aspects and one to the cost of the proposed policy (expressed as dollar amounts per year). Each environmental attribute represents a threatened native species identified as important to New Zealanders. These species were selected based on a series of four focus group meetings with a variety of stakeholders (see Yao, 2012 for details). The species included were the bird brown kiwi (*Apteryx mantelli*)[1], the fish giant kokopu (*Galaxias argenteus*), the plant kakabeak (*Clianthus maximus*), the lizard green gecko (*Naultinus elegans elegans*) and the bird bush falcon (*Falco novaeseelandiae*) (Figure 2). Each attribute was described using three levels of species abundance that can be supported by planted forests, as advised by ecologists and forest managers. The base level represents the current level of abundance. From the current condition, we identified a feasible expansion to an intermediate level of improvement (Level 1) and to a higher level still (Level 2). Adequate levels of a "realistic" payment over a period of five years were identified from two focus groups as \$30, \$60 and \$90. The survey was constructed then was tested on a test group of 10 respondents at the location of the study. These respondents represented a small sample of the population likely to be completing the survey. Respondents were asked to complete the survey, and then were asked a series of questions regarding the ease of completing the survey and clarity of the survey questions. Adjustments were made accordingly to finalise the survey instrument.

[Figure 2 goes about here]

[1] Brown kiwis are nocturnal birds. People would not necessarily expect to see a kiwi in the wild but appreciate hearing a kiwi call.

Before showing the actual valuation questions in the questionnaire, we provided each respondent with an overview of the location and the current situation of the species in the choice task (Figure 3). After this overview, we described the proposed biodiversity programme and presented a walk-through example of how one could select the preferred alternative in each choice task (an instruction choice task). In the valuation scenario, we included a "cheap talk" script as recommended by Cummings and Taylor (1999). Some of the reasons for including the script are to specifically draw the respondent's attention to the cost variable and to remind respondents that they could use their money to buy other things they enjoy (Cameron et al., 2011). The script also includes statements that made clear the consequentiality of the survey (Vossler et al., 2012). The cheap talk script seen by respondents is presented in Appendix A.

After the warm up exercise, the valuation scenario was presented. In the valuation scenario, it was mentioned that payment for the biodiversity programme will be paid via income tax annually for five years.[2] The payment amount will be forwarded to the Department of Conservation (DOC) who will coordinate with forestry companies and other

[2] We chose income tax because biodiversity conservation is a pure public good and as such it should be funded by the central government. We realise that in our sample the fraction of respondents not income paying taxes is higher than the NZ average. We assume that for most this is only a temporary and not a permanent condition over the five year period that the payment is hypothesized for. As such the incentive compatibility of this payment vehicle should not have been seriously affected.

concerned organisations to undertake the proposed programme.[3] Respondents were then asked to evaluate a series of nine choice tasks.

[Figure 3 goes about here]

2.2 Experimental design

In CE, experimental design criteria are used to generate the different choice tasks for the indirect valuation of the environmental good in question. Several design criteria have been developed (Scarpa and Rose, 2008; Burgess and Street, 2005). Designs generated using different criteria vary mainly in terms of statistical properties, which include orthogonality and efficiency (Rose et al., 2011).

In this present study, we employed a sequential experimental design by administering the survey in two waves following Scarpa et al. (2007a) and Kerr and Sharp (2010). An orthogonal main effects design was used for the first wave of 35 respondents. This initial design was used as we did not have prior knowledge about the values of the

[3] We developed this hypothetical market based on consultations with key staff members of the Department of Conservation, forest managers and focus group participants. The market was designed to allow respondent's utility be affected by the different levels of biodiversity outcomes for them to truthfully select the preferred alternative in each choice task. These, plus the inclusion of a cheap talk script, represented our best effort towards inducing respondents in our hypothetical market to provide us with truth revealing WTP responses (DOI (1994) as cited by Harrison (2006)). This is in line with the current state of survey practice in non-market valuation.

indirect utility coefficients. Data collected from the first wave were used to estimate the parameters of a multinomial logit model (Appendix B). Estimates of utility coefficients and corresponding standard errors were used to generate three new experimental designs. All three designs were Bayesian efficient designs but each optimised a different criterion (D-efficiency, C-efficiency and S-efficiency) using the design software NGENE (ChoiceMetrics, 2011). We also generated a fourth design, i.e., an optimal orthogonal design, also designed using NGENE. *A priori* values were not used in the fourth design because this assumes that the utility coefficients are all zeroes. The four new experimental designs were used to construct the choice tasks for the second wave of the survey. As can be expected, experimental designs for the second wave had higher design efficiency compared to the orthogonal design (base design). Comparing the design efficiency to the base orthogonal design, the Bayesian D-efficient design improved by 8.4 percent in terms of Bayesian D-error while the optimal orthogonal improved by 11.4 percent in terms of D_z-error (Yao, 2012). Details about the methods for evaluating design efficiency can be found in Scarpa et al. (2007a) and Scarpa and Rose (2008).

In splitting the sample by design, we did not find significant differences in WTP estimates. To the best of our knowledge, there is no study yet that examines the impact of using a combination of the experimental designs used in this study. However, we can assume that the impact of using such mixture of designs on the estimates would be minimal because each design might tend to offset its impact on the other given the difference in optimisation criterion (e.g., Bayesian D-efficiency, orthogonality). Perhaps a future study that evaluates the impacts of such mixture of designs would shed light on this issue.

2.3 Sampling Frame, Survey Method and Choice Survey Sample

We employed a stratified sampling approach based on the distribution of the population. In 2006, 92 percent of New Zealand households had land based telephones (SNZ, 2011). We employed a combined phone-mail and phone-internet survey approach. With this two-stage survey technique we first called people listed in the phone book and asked if they were interested in participating in a survey and then collected their survey response in the mode they preferred, internet or mail. Three survey assistants with native accent were employed to randomly call by phone and invite people to take part. Since a large majority of respondents indicated interest in completing the survey by mail, a decision was made relatively early on to focus mainly on surveys collected by phonemail. A total of 2,996 phone calls were made between December 2009 and August 2010. About 781 people (26 percent of the numbers called) agreed on the phone to participate in the survey. The final sample consisted of 261 completed surveys (33 percent of the surveys sent) of which 84 percent were collected via mail and 16 percent online.[4] Of the completed surveys, 209 survey respondents provided valid responses for the CE questions and their responses to our debriefing questions did not show any sign of protest. Of the 52 respondents (261 minus 209) who did not evaluate the choice questions, 17 appeared to have protested on

[4] The second stage response rate of 33% (261 out of the 781 survey sent). This is very low compared to the phone-mail survey of Yao and Kaval (2010) which had a second stage response rate of 88% (709 out of the 803 survey sent). However, low survey response rates were also experienced in other surveys such as Johnston and Roheim (2006) with 31% and Wordsworth el al. (2006) with 32%, and Chen et al. (2010) with 29%.

how the questionnaire was designed. Statistics New Zealand reports that the ratio of urban to rural households in 2006 was 72 (urban) to 28 percent. Due to our low response rate, we were unable to match exactly these sample proportions. In the final sample, the ratio was 60:40.

2.4 Determinants of WTP

Our study examines the effects of the location of residence of respondents with respect to large planted forests, which can be found in many different areas of New Zealand. We tried to locate the geo-referenced spatial coordinates of respondent's place of residence. Respondents' existing addresses in the database were first verified using New Zealand Post's address-postcode-finder. Once confirmed, specific latitude and longitude coordinates for all addresses were found using the web site http://stevemorse.org/jcal/latlon.php which uses GoogleMaps to identify coordinates.[5] Spatial coordinates of several online respondents were not located because of the absence of accurately verified addresses (e.g., their addresses were incomplete in the phone directory). Of the 209 respondents who provided valid choice observations, we located spatial coordinates of 115 respondents.

Given that there are multiple sites with large planted forests, we developed a method where the geo-spatial coordinate of each respondent was used to create geographical zones with radius of 10-, 50- and 100-kilometre using ArcInfo© 9.10 and the

[5] More information regarding how we derived spatial coordinates (latitude and longitude coordinates) which include additional websites can be provided upon request to richard.yao@scionresearch.com.

programming language Python 2.6. The 10-, 50- and 100-kilometre zones were chosen to respectively represent biking distance, one-day trip and at the border of a one day trip to the planted forest of interest. Using a second digital layer that contains the New Zealand Land Cover Database version 2 (Ministry for the Environment, 2011), each zone was intersected with the sum of the area of planted forests, thus enabling the identification of planted forest areas around each geo-spatial coordinate. A further step was taken to consider that threatened native species could only establish themselves in large forests. Native species, especially native birds, benefit more from larger forests. The New Zealand bush falcon benefits from a mosaic of forest plots of different ages (Seaton, 2007). To form such landscape, we have assumed that a large planted forest to be at least 5,000 hectares, such as those that can be found in New Zealand's Central North Island region, that provide habitats for many native bird species. To determine those large forest areas, contiguous planted forests of more than 5,000 hectares were aggregated and all the other scattered forests were ignored, and this procedure created the final set of zones or spatial intersections. We used the area of large planted forests derived from spatial intersections to create the spatial zone variables that we used as spatial covariates in the panel least squares regression model. We also included other covariates from the survey data such as socioeconomic characteristics, attitudes, and affiliation to conservation organisations to further explain the variation in individual specific WTPs.

3. Models

3.1 Random Parameters Logit Model

Random parameters logit (RPL) models (also known as mixed logit models) provide a computationally practical and flexible econometric approach to the analysis of discrete choices. It is based on random utility maximisation, but does not suffer from a series of restrictive behavioural assumptions (McFadden and Train, 2000). It is now well documented that RPL models overcome limitations of the basic conditional logit model (Hensher and Greene, 2003; Revelt and Train, 1998; Train, 2009). Under the RPL approach, the unobserved portion of utility is partitioned into two additive terms. A first one is heteroskedastic and correlated over alternatives (η) while the other is i.i.d. over alternatives (ε) as showed in Equation 1

$$U_{njs} = \beta_k X_{nkjs} + \eta Z_{nk} X_{nkjs} + \varepsilon_{njs} \tag{1}$$

where η is a random term with distribution over individuals, which depends on the underlying parameters and observed data relating to respondent n; j denotes alternatives in choice task s; ε is the unobservable component of utility, which is assumed to be an i.i.d. extreme value Type I distributed random term (Hensher and Greene, 2003). The η may be assumed to have a particular distribution postulated *a priori*. Frequently used distributions include normal, lognormal, truncated normal, triangular, Weibull and exponential. Assuming normal and lognormal distributions can be problematic as the former is sensitive to having some respondents with "theoretically invalid" signs (e.g., positive cost coefficient) while the latter exhibits a long tail (Train and Weeks, 2005). These properties are relevant to the current study of valuing biodiversity enhancements where taste intensities (or attribute coefficients) are expected to be positive for various improvements from the status quo. We employed an RPL model with panel specification that facilitates the estimation of the conditional means of the implied WTP distributions for each respondent (Train, 2009).

Although the basic RPL model, as mentioned above, accounts for heterogeneity in the sample, it still does not account for the effects of correlation between the two designed alternatives in the choice task. Respondents may consider the status-quo alternative in a systematically different manner from designed alternatives, because the status-quo alternative is experienced while the designed alternatives are hypothetical (Scarpa et al., 2005) and therefore only conjectured, especially when unfamiliar. The utilities derived from the designed alternatives would hence likely be more correlated between themselves than the utilities derived from a changed alternative and the status-quo alternative. This correlation structure can be accounted for by specifying a RPL model with additional errors that consider the difference in correlation across utilities (Herriges and Phaneuf, 2002). Specifying this RPL model with the additional error component addresses the status-quo bias (Samuelson and Zeckhauser, 1988; Haaijer, 1999; Haaijer et al., 2001; Hess and Rose, 2009) and state dependence (Hensher, 2008) effects.[6]

3.2 Panel data regression of WTPs

Campbell (2007) and Scarpa et al. (2011) have used panel random effects regression models to determine the factors influencing WTP for the improvement of environmental goods. This is a two-step validation method for testing the effects of socio-demographic covariates on individual WTPs. We employed this modelling approach because, in preference space utility specifications, WTP is a function of the coefficients of the cost attribute and other non-monetary attributes. Two individuals with different conditional

[6] "Status-quo effect" is also referred to as "status-quo bias" in other papers. State dependence is defined by Hensher (2008) as "the influence of the actual (revealed) choice on the stated choices of the individual".

parameter estimates can have the same estimated conditional mean WTP. As a result, a validity regression on conditional means is more likely to detect systematic effects of socio-economic covariates on WTP variation than it is to detect these effects on random parameter estimates of the utility function. In fact, in many datasets, one fails to identify significant socio-economic covariates as taste parameter shifters, but then when one goes on to a second stage regression on individual WTPs, one finds significant socio-economic covariates effects on such conditional mean WTP estimates. For example, Scarpa and Thiene (2005) failed to identify any socio-economic variable to have an effect on membership probabilities in a latent class model of choice of destination for mountain visitation by climbers in the European Alps. However, when fitting a binary choice model to explain whether each climber was posterior-predicted to be a beneficiary from a certain policy, they found that number of trips to be highly significant and annual income to be nearly significant. Campbell (2007) also used a panel of individual specific means of the conditional distributions of marginal WTP values as the dependent variable, and socioeconomic characteristics and location as explanatory variables. His results suggested that income levels, community type and location significantly influence WTP. Similarly, Scarpa et al. (2011) used a panel of individual specific means derived from the conditional distributions of WTP as dependent variable and found socioeconomic characteristics (such as marital status or education level) explained reasonably well the variability in conditional means of marginal WTP. The above studies identified determinants of posterior WTP estimates from choice models in terms of socioeconomic characteristics and attitude of respondents, but none included distance of the respondents' places of residence from the public amenities under study.

While analyses of CE data that account for the spatial distributions of WTP estimates have been produced (Concu, 2007; Campbell et al., 2008; Campbell et al., 2009), those that focused on the effects of distance from the source of externality on WTP represent a growing area of research in the SP literature (Garrod et al., 2002; Schaafsma, 2010; Johnston et al., 2011; Rolfe and Windle, 2012). Several CV studies have used distance-decay models and found that WTP is negatively associated with the distance of the individual from the environmental good in question (Sutherland and Walsh, 1985; Loomis, 1996; Bateman et al., 2000; Hanley et al., 2003; Bateman et al., 2006; Cameron, 2006; Mazur and Bennet, 2009). However, Johnston et al. (2011) found no clear pattern of global distance decay on WTPs from a CE study because of the occurrence of non-continuous spatial variation. Johnston identified the presence of WTP hotspots in a stated CE framework by applying the Getis-Ord statistic (Getis and Ord, 1992).

In this study, we derived the means of marginal WTP distributions for each respondent conditional on observed choice (see von Haefen, 2003 for details). As we used a choice task with five non-monetary attributes, with each having two improved levels, we had 10 conditional means (one for each attribute with random coefficient) per respondent. We wished to try and see how the variation of these WTP estimates can be explained on the basis of socio-economic characteristics of respondents, such as distance between place of residence and forests, taking into account the fact that these conditional means estimates are correlated when they pertain to the same respondent. So, we used a panel regression instead of the standard OLS regression and use it on the subset of respondents who provided us with the relevant socio-economic and spatial variables during the survey. We specify the panel regression as:

$$W_{na} = \alpha_n + \varphi A_{na} + \psi R_n + \delta S_n + \varepsilon_{na} \quad (2)$$

where W_{na} represents a 10-period panel of WTP for attribute level a for respondent n, α_n represents independent random variables with constant mean and variance, A_{na} is a vector of indicator variables for k minus one attribute levels, R_n represents a vector of socio-economic characteristics, attitude and affiliations of respondent n, S_n is a vector of the natural log of areas of large planted forest included within a particular unit of radius from respondent n (e.g., 10-kilometre radius, between 10- and 50-kilometre radius, between 50- and 100-kilometre radius), while φ, ψ, δ, ε are unknown parameters to be estimated. As a semi-log specification form is used for W_{na} and S_n, the estimated value of δ can be interpreted as the change in WTP due to a percentage change in area of large planted forests in that particular zone.

4. Data

Two data sets were used in the analysis. The first data set consisted of 1,850 choice observations collected from 209 respondents across New Zealand. Almost all (98 percent) of these respondents completed all nine choice tasks that they were presented with. This data set included the choice variable and choice attribute variables with panels of nine observations from respondents who completed all nine choice tasks. This was analysed using logit models. The second data set included a secondary variable with respondent-specific conditional means of marginal WTPs.

A summary of the socio-economic characteristics of the sample of respondents is given in Table 1. Our sample was biased towards high income with 34 percent of the respondents having a household income above $100,000. As a whole, only 22 percent of New Zealand's population had this level of income in 2006 (Statistics New Zealand 2010).

[Table 1 goes about here]

Forty-four percent of the respondents had tertiary or post-graduate education while 64 percent were women (Table 1). These proportions are slightly higher than the national proportions of 40 percent for higher education and 51 percent for women (Statistics New Zealand 2010). In terms of the sample proportion not in the labor force, this is also slightly higher (39 percent) compared to the value reported in the national statistics (32 percent). Only a small proportion of respondents reported they were volunteers in conservation organizations. One out of five of the respondents wanted to include the tui (*Prosthemadera novaeseelandiae* a popular non-threatened native bird) in the choice tasks. We asked respondents about their attitude toward supporting the proposed programme and found that 18 percent had the "Government-should-pay" attitude. This type of negative attitude is often labeled as a protest bid in the literature but it is not necessarily the case (Brouwer and Martin-Ortega 2012). Our data indicate that five percent of the respondents who selected some non-status-quo alternatives also had the "Government Should Pay" attitude for the proposed programme. Respondents also rated their level of understanding of the choice questions after completing the nine choice tasks. Twenty-one percent of the respondents gave a rating of 10 indicating that only one out of five respondents completely understood the choice questions.

A summary of the spatial variables used as covariates in the OLS panel regression analysis is provided in Table 2. We located geo-spatially referenced coordinates of 115 respondents. Twenty eight of these (24 percent) were less than 10 kilometres away from one or more sections of large planted forest (with a contiguous size of at least 5,000 hectares). The sections of forest contained within each 10-kilometre zone range from 17 to 14,000 hectares. Large planted forests are scattered throughout New Zealand. Therefore, someone residing within a 10-kilometre radius of a section of a large forest can also be within a 10-50 kilometre radius of another large forest (membership to forest zones is not mutually exclusive). Of the 28 respondents with forests less than 10 kilometres away, 25 were also within the 10-50 kilometre radius of another forest. Overall, about 71 percent of the respondents lived in areas situated 10 and 50 kilometres from a large forest. Unsurprisingly, the sections of forest located in each 10-50 kilometre zone range from 1,900 to 220,000 hectares, given that the 10-50 kilometre zone covers a larger area than the 10-km zone. The remainder of the respondents lived within 50-100 kilometre of a large planted forest.

[Table 2 goes about here]

5. Results and Discussion

5.1 Logit model estimation

Estimates from the random parameters logit (RPL) model with panel specification are presented in Table 3. This RPL model contains random parameters for selected attributes and for the status quo effect. The RPL model was estimated using 5,000 Halton draws. The random parameters for selected attributes account for the fact that each respondent has a unique set of preferences for the attributes describing the proposed biodiversity conservation policies. To identify which parameters are random, we tested more than 20 different specifications. Based on this search we identified four parameters as random and these are Bush Falcon 2, Kakabeak 2, Green Gecko 2 and Cost. The three environmental attribute parameters are assumed to have unrestricted triangular distribution while the cost parameter is assumed to have a constrained triangular distribution (as proposed by Hensher and Greene (2003)).[7] The spreads of the four random parameters are significant at the five percent level indicating taste heterogeneity.

We have also included a random parameter for the status quo effect which is called as "error component". This induces the correlation amongst the two designed alternatives as described in Scarpa et al. (2005). Results indicate a strong correlation between the two designed alternatives as indicated by the coefficient for the error component being positive and significant.

Model estimates suggest strong preference for the protection of native bird species as indicated by significantly positive coefficients for the two improved levels of Brown Kiwi and Bush Falcon. Higher levels of bird abundance are valued more as indicated by higher coefficients for Brown Kiwi 2 and Bush Falcon 2 than the level 1 improvement. However, this does not apply to fish as the coefficient for Kokopu 1 is significantly positive but not so for Kokopu 2. This demonstrates a pattern of insensitivity to scope which has been previously identified as a potential issue in CV and in CE (Ryan and Wordsworth, 2000; Foster and Mourato, 2003; Goldberg and Roosen, 2007; Rolfe and Windle 2010).

[7] We have used unrestricted triangular for the environmental attributes to allow the WTP to vary between positive and negative. For example, some people might have a negative preference for geckos which may be regarded as undesirable "creepy crawlies". Constrained triangular distributions are often or primarily used to constrain a random coefficient's variation to a given sign or neighbourhood of values. In our case, instead, we used the unconstrained triangular for the random coefficients because this choice of distribution fit the data better than alternative ones (e.g., normal and log-normal).

However, Banerjee and Murphy (2005) argued that insensitivity to scope was not a necessary condition for preference consistency. From this perspective, we find our WTP estimates to be valid.

Based on the model specification above, we simulated the conditional means and medians of individual WTP distributions for each of the 209 respondents. A summary of these values is given in Table 4. Median WTP values suggest that the two most valued attribute levels are level 2 increases in Falcon ($24/year) and Brown Kiwi ($21/year). We also report the 5^{th} and 95^{th} percentile WTP for more Falcon ($14 to $91) and Kiwi ($13 to $76). The above results suggest that higher WTP values have been placed on birds compared to other species. In terms of attributes levels, we find that a level 1 increase in abundance of Kakabeak and the Giant Kokopu were valued at approximately $8 and $9 a year, respectively. The level 1 increase in Kokopu is valued, while the level 2 increase is not (Table 4). The coefficients for Gecko 1 and Gecko 2 are insignificant. One may argue that this attribute should have been excluded in the investigation. However, Gecko was included because of its importance for wildlife management.

[Table 4 goes about here]

5.2 WTP determinants

We used panel random effects regressions to explain patterns of variation in individual specific WTP of the sample of respondents. In the set of explanatory variables, we included indicator variables for all but one attribute level to avoid the dummy variable trap for the different types of marginal WTP estimates provided by each respondent. We explore the role of socioeconomic characteristics, attitudes and geo-spatial distance of each respondent on WTP values. The estimates for the panel regression model are shown in

Table 5. As some respondents did not report their socio-economic data, the sample size was reduced to 1,600 observations. Also as some respondents were not located due to insufficient data, the sample size was further reduced to 1,110 observations.[8]

Results from the reduced sample of respondents show a significantly positive coefficient for Higher Education which suggests that being a respondent who completed at least tertiary education positively affects WTP by about NZ$2.90 (Table 5). Being part of the labour force contributes to a higher WTP of NZ$3.60 than those who were not in the labour force (e.g., students, retired, homemakers (such as housewives)).[9] Results from this sample indicate that being a Department of Conservation volunteer or a Forest and Bird member, had the greatest positive effect on WTP among other characteristics. As expected, a respondent with a “Government Should Pay” attitude would have a WTP lower by NZ$3.13.

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[8] Despite the reduction in sample size, we have no reason to believe that missing data points on geographical location of residence is correlated with distance to forests, which is our variable of interest. Therefore, we expect our result to maintain validity for the purpose of our discussion.

[9] In New Zealand people not in the labour force (e.g., retired), still pay income taxes. Homemakers and adult students are also required to file (and if needed pay) their income taxes even when they do not have work income in that tax year. In this study, the proportion of respondents who were not in the labour force was higher than the national average. This is often the case in survey research due to the fact that the cost of time of this category of people is lower than that of those in the labour force (e.g., Kaval et al. (2009)).

Results from a restricted panel regression model that do not have spatial covariates but with a larger sample size (160 respondents), show that a respondent who indicated that "Tui Should be in the Choice Task" would be willing to pay $2.67 more while a "Female" would pay $2.42 more. These coefficient estimates are both statistically significant at the 99% confidence level in that side regression. However, estimates in Table 5 (model with spatial covariates with 110 respondents), these two coefficients are no longer statistically significant.

In terms of the effects of the spatial zone covariates to WTP, the significantly positive coefficient for the 10-kilometre radius suggested that a respondent who resides within a 10-kilometre radius of a large planted forest would pay $2.20 more for a 10 percent expansion in forest area with a biodiversity programme. This might indicate a form of use value associated with living within biking distance of a large planted forest. Results also indicate that the WTP of a respondent living within the 10 to 50-kilometre radius would not have a significantly different WTP. A possible reason for this is that people perceived that the potential to benefit from enhanced biodiversity is low as it would likely take a day to visit that forest. A respondent residing within the 50 to100-kilometre radius had a slightly higher WTP of $2.25 for a 10 percent increase in forest area with biodiversity. This might indicate the presence of option-use values to respondents who live further away from planted forests. They would be willing to pay more by knowing that the area of habitat for threatened species would increase even though they are not likely to visit those forests immediately, but maybe some time in the future. However, the estimate for the dummy variable of living "within the 50-100-kilometre radius" is significant only at the 90 percent confidence level and therefore statistically weak compared to the coefficient estimate for the "10-kilometre" zone.

6. Conclusions and Policy Implications

Our results from a CE survey conducted on a sample of New Zealand residents indicate that biodiversity enhancement in large planted forests is valued. Native species are appreciated more than exotics in the country, so the value to a greater extent pertains to the increase in abundance of native species, and to a lesser extent the exotic forest landscape. A typical respondent would be willing to pay for such native enhancement via an increase in income tax. The money would be destined to the Department of Conservation which, in coordination with forest companies, would implement the proposed programme to increase the number of threatened species seen or heard in New Zealand planted forests. In terms of policy use of this information, it is important to have a measure of individual variation of WTP to identify its determinants. An understanding of the fact that WTP is higher for those who reside closer to commercial forest may help the calibration of a potential conservation tax.

This study extends previous work by Yao and Kaval (2010) showing that a sample of New Zealanders would pay for biodiversity enhancement on private land. This study demonstrates that even in productive, planted forests, some New Zealanders still value habitat enhancement for threatened native species. The estimated value may be useful not only for future government policy decision making but also to satisfy the growing interest of large corporations to include ecosystem services values in business plans (MEA, 2005; TEEB, 2010; WBCSD, 2011). For instance, the recent UK National Ecosystem Assessment recognises that biodiversity conservation has an economic value that should be considered in evaluating changes in ecosystems (UKNEA, 2011). In addition, members of the business community have been reported as being keen to work with policy makers to ensure that biodiversity and ecosystem values be integrated into policy and regulation of productive activities (WBCSD, 2011). Despite its obvious limitation in response rate, this study complements results from previous studies that indicate that although forest companies would need to incur a significant increase in cost to support biodiversity enhancement (e.g., Raunikar and Buongiorno, 2006; Yao et al., 2012), the general public would be willing to financially support such an initiative from this commercially productive ecosystem. Also, given the small sample size, our results should not be aggregated over the total New Zealand population.

While previous studies separately identified the socioeconomic and spatial (distance) determinants of WTP (e.g., Campbell, 2007 – socioeconomic effects; Schaafsma, 2012 – socio-demographic characteristics and directional distance effects), this study identified the effects of both groups of determinants and other factors. This study extends previous work by explaining the effects of socio demographic characteristics, affiliation and attitudes on WTP and found results similar to those reported in previous studies (e.g., Campbell (2007), Scarpa et al. (2011) and Rosenberger et al. (2012)). We also examined the impact of distance from place of residence of respondents to their closest large planted forests and found evidence that respondents tend to have a higher WTP when they live closer to the environmental good which might suggest a type of use value. Future studies may cast additional light to the finding of higher WTP by those who are more likely to use the resource. For example, the impact of a proposed programme on the use, option use and non-use values of biodiversity enhancement through distance effects could be explored, while also accounting for the effect of socio economic characteristics on WTP.

Future investigations should explore whether or not estimates of WTP amounts would support the cost of attaining target outcomes (e.g., increasing falcon sightings in the Kaingaroa Forests from one-out-of-eight to five-out-of-eight drives). The New Zealand Department of Conservation currently supports the conservation of key threatened species (e.g., brown kiwi) on public conservation land in cooperation with the private sector (DOC, 2012). A future study could, for example, examine mechanisms that would facilitate conservation of such species on private land. Such study may follow the one conducted by Horne et al (2005) that evaluated different biodiversity enhancement schemes such as compulsory land acquisition and voluntary conservation. Perhaps it could compare existing schemes such as those already established in New Zealand, e.g., Operation Nest Egg (Colbourne, 2005) and with those already established elsewhere, such as species conservation banking (Fox and Nino-Murcia, 2005).

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Table 1

Characteristics of respondents and the national proportion

Item	Proportion of respondents (%)	National proportion (%) *
Household income range		
$20,000 or less	9	9
$20,001–$30,000	11	12
$30,001–$50,000	17	20
$50,001–$70,000	12	18
$70,001–$100,000	17	19
$100,001 or more	34	22
Other household characteristics		
Completed higher education (tertiary or post-graduate)	44	40
Female	64	51
Not in the Labour Force	39	32
Forest and Bird Member	8	--
Department of Conservation (DOC) Volunteer	3	--
Tui should be in the choice set	21	--
Government should pay	18	--
Self-rated understanding of CE questions ("10" represents "completely understood" and "1" represents "did not understand at all")		
– 8 to 10	47	--

– 5 to 7	42	--
– 1 to 4	11	--

* Source: Statistics New Zealand (SNZ)

Table 2

Summary statistics for the three spatial covariates in the OLS panel regression

Spatial covariate (Buffer zone size and range of forested areas within each zone)	Area of planted forests within the radius (hectares)	Number of respondents (% of 115 respondents with spatial coordinates)*
10-km radius		28 (24%)
– Average	3,936	
– Minimum	17	
– Maximum	14,000	
Between 10- and 50-km radius		82 (71%)
– Average	40,175	
– Minimum	1,900	
– Maximum	220,000	
Between 50- and 100-km radius		29 (25%)
– Average	62,334	
– Minimum	6,200	
– Maximum	770,000	

(*) Membership to buffer zones is not mutually exclusive

Table 3

Estimates from RPL Panel with Error Components

Item	Estimates						
	Coeff	Std Err	*p*-value	Assumed distribution	Spread of Random Parameter	Std Err	*p*-value
Brown Kiwi 1	0.898	0.137	<0.01				
Brown Kiwi 2	1.048	0.128	<0.01				
Kokopu 1	0.311	0.153	0.04				
Kokopu 2	0.133	0.145	0.36				
Kakabeak 1	0.330	0.164	0.04				

Kakabeak 2	*0.324*	*0.161*	*0.04*	*Unres Tri*	*1.309*	*0.536*	*0.01*
Green Gecko 1	0.052	0.133	0.70				
Green Gecko 2	*0.123*	*0.159*	*0.44*		*1.486*	*0.553*	*0.01*
Bush Falcon 1	0.907	0.149	<0.01				
Bush Falcon 2	*1.178*	*0.145*	*<0.01*	*Unres Tri*	*1.484*	*0.661*	*0.02*
Status Quo (SQ) Indicator	-1.333	0.721	0.06				
Cost	*-0.063*	*0.004*	*<0.01*	*Restricted Tri*	*0.063*	*0.004*	*<0.01*
Error component (σ_ε)				*Normal*	*7.674*	*1.007*	*<0.01*

Log-likelihood	-992.79
Normalised AIC	1.091
McFadden Pseudo R^2	0.512
No. of observations	1850

Note 1: Attributes in *italics* are random parameters with corresponding spread parameters.

Note 2: Green Gecko 1 serves as the reference attribute level.

Table 4

Summary of simulated willingness-to-pay (n = 209). (Individual specific WTPs derived from RPL-EC model from Model 3 in Table 3)

	Mean WTP	Median WTP	Std Dev	5th percentile	95th percentile
Brown Kiwi 1	24.18	18.07	16.78	11.42	64.79
Brown Kiwi 2	28.24	21.10	19.59	13.33	75.64
Kokopu 1	8.37	6.25	5.81	3.95	22.43
Kokopu 2	*NS*	*NS*	*NS*	*NS*	*NS*
Kakabeak 1	8.89	6.64	6.12	4.19	23.80
Kakabeak 2	8.37	6.05	8.59	0.75	26.51
Green Gecko 1	*NS*	*NS*	*NS*	*NS*	*NS*
Green Gecko 2	*NS*	*NS*	*NS*	*NS*	*NS*
Bush Falcon 1	24.44	18.26	16.96	11.54	65.48
Bush Falcon 2	31.68	23.63	23.86	13.50	91.01
Indicator for SQ	*NS*	*NS*	*NS*	*NS*	*NS*

Note: *NS* means the coefficient is not statistically significant at the five percent level.

Table 5

OLS panel regression model parameter estimates

	Estimates		
	Coeff	Std Err	*p*-value
Indicator for attribute level			
Brown Kiwi 1	25.401	1.571	<0.01
Brown Kiwi 2	29.424	1.571	<0.01
Kokopu 1	9.708	1.571	<0.01
Kokopu 2	4.955	1.571	<0.01
Kakabeak 1	10.216	1.571	<0.01
Kakabeak 2	10.053	1.571	<0.01
Green Gecko 2	5.057	1.571	<0.01
Bush Falcon 1	25.659	1.571	<0.01
Bush Falcon 2	32.432	1.571	<0.01
Constant	-5.801	2.942	0.05
Socioeconomic covariate			
Higher Education	2.899	0.823	<0.01
Female	-0.516	0.772	0.50
Being Part of the Labour Force	3.595	0.721	<0.01
Forest and Bird Member	12.655	1.291	<0.01
DOC Volunteer	9.936	1.970	<0.01
Understanding of CE questions	0.386	0.162	0.02
Tui Should be in the Choice Task	-0.336	0.870	0.70
Government Should Pay	-3.128	0.917	<0.01

Spatial covariate			
Log (forest area within 10 km radius)	0.219	0.056	<0.01
Log (forest area within 10 to 50 km radius)	-0.027	0.106	0.80
Log (forest area within 50 to 100 km radius)	0.225	0.119	0.06
Log-likelihood	-4295.201		
Adjusted R^2	0.531		
Number of observations	1110		
Number of respondents	111		

Threatened Animal/Plant		*Current Condition*	*Option I*	*Option J*
Brown Kiwi (Frequency of hearing calls in planted forests in North Island)		Kiwi calls heard **in 1 out of 200** planted forests	Kiwi calls heard **in 1 out of 200** planted forests	Kiwi calls heard **in 20 out of 200** planted forests
Giant Kokopu (Occurrence in slow moving streams with overhanging native vegetation in planted forests throughout New Zealand)		Kokopu seen **in 1 out of 10** suitable streams	Kokopu seen **in 3 out of 10** suitable streams	Kokopu seen **in 1 out of 10** suitable streams
Kakabeak (Occurrence in 20% of the planted forests on the East Coast and Hawke's Bay)		At least **3 naturally occurring** Kakabeak shrubs	At least **20 actively managed** Kakabeak shrubs	At least **3 actively managed** Kakabeak shrubs
Auckland Green Gecko (Gecko sightings in open grounds in planted forests in Northland, Waikato and Bay of Plenty regions)		Gecko sighted **in 1 out of 50** walks	Gecko sighted **in 3 out of 50** walks	Gecko sighted **in 1 out of 50** walks
NZ Bush Falcon (Bush falcon sightings while driving through pine forests in Central North Island and Nelson)		Bush falcon sighted **in 1 out of 8** drives	Bush falcon sighted **in 5 out of 8** drives	Bush falcon sighted **in 1 out of 8** drives
Additional amount to be paid yearly in your income tax for five years only		**$0**	**$30**	**$30**
I would choose (please tick)		☐	☐	☐

Fig. 1. An example of a choice task used in the survey

Threatened Animal/Plant		*Current Condition*	*Level 1*	*Level 2*
Brown Kiwi		Kiwi calls heard **in 1 out of 200** planted forests	Kiwi calls heard **in 10 out of 200** planted forests	Kiwi calls heard **in 20 out of 200** planted forests
Giant Kokopu		Kokopu seen **in 1 out of 10** suitable streams	Kokopu seen **in 3 out of 10** suitable streams	Kokopu seen **in 5 out of 10** suitable streams
Kakabeak		At least **3 naturally occurring** Kakabeak shrubs	At least **10 actively managed** Kakabeak shrubs	At least **20 actively managed** Kakabeak shrubs
Auckland Green Gecko		Gecko sighted **in 1 out of 50** walks	Gecko sighted **in 3 out of 50** walks	Gecko sighted **in 5 out of 50** walks
NZ Bush Falcon		Bush falcon sighted **in 1 out of 8** drives	Bush falcon sighted **in 3 out of 8** drives	Bush falcon sighted **in 5 out of 8** drives

Fig. 2. The five native species with the current and proposed levels of provision

	***Brown Kiwi*** Throughout New Zealand, the **brown kiwi** population has been declining at a rate of 5% per year, which implies their population halves every decade. Conservation initiatives have started to ensure that the brown kiwi continues to live in a few exotic forests. They can be found in planted forests in **Northland**, **Coromandel**, **Central North Island**, **Bay of Plenty** and **Hawke's Bay** that also contain remnants of native trees, stream edges with trees, clearfell and stands of various ages. The brown kiwi is nocturnal and can be heard calling after dark.
	***Native Fish*** The **giant kokopu** is a rare native fish whose populations are gradually declining throughout New Zealand. They can be found in suitable waterways in planted forests in **Bay of Plenty**, **East Coast**, **Waikato**, **southern North Island, West Coast** and **Southland**. They can be seen at night in gently flowing streams with overhanging native vegetation.
	***Native Shrub*** The **kakabeak** is a widely cultivated shrub, however, natural populations are extremely rare in the wild. Kakabeak has been found in planted forests on the **East Coast** and **Hawke's Bay,** where they are found in stream edges with trees and in steep gullies.
	***Native Lizard*** Populations of the **Auckland green gecko** are in gradual decline. Populations have been found in planted forests in **Northland**, **Waikato** and **Bay of Plenty** regions. They have well developed vocal cords and can bark or chirp by clicking their tongues against the roof of the mouth. They can be seen in tree branches, foliage and open ground. Although they hunt by night for insects, they also like to sunbathe.
	***NZ Bush Falcon*** The **NZ bush falcon** is classified as vulnerable to extinction. Very few bush falcons can be sighted on native bush but many can be found in large planted forests in North Island which include **Kaingaroa Forest** in the **Central North Island** and in **South Island** planted forests including the **Golden Downs in Nelson**. They can be sighted in forest stand edges between clearfell and mature stands.

Fig. 3. Location and situation of the five native species in the choice task

Appendix A

Example of the cheap talk script presented to the survey respondents.

We are now going to present you with a number of choice situations. These describe the outcomes of conservation policies that could be undertaken by the Department of Conservation in partnership with concerned organisations (e.g., forest corporations). Ecologists suggest that over the next five years, planted forests could be managed to provide better habitat for threatened species. These species include the above four threatened animals and one plant species. For each choice situation we present you, we will ask you to select the alternative with the conservation outcomes you prefer. Some outcomes will require a contribution to the Department of Conservation through an additional amount in your annual income tax for five years. In each choice situation, there is also the possibility of taking no conservation action ("Current Condition") and paying no money.

Please remember to consider the payment as if it was real and give honest answers so as to inform conservation policy.

Appendix B

Estimates of multinomial logit model coefficients from the pilot sample of 35 respondents.

	Coefficient	Standard Error	T-ratio	P-value
Brown Kiwi 1	0.462	0.252	1.832	0.067
Brown Kiwi 2	0.591	0.251	2.354	0.019
Kokopu 1	0.242	0.241	1.002	0.316
Kokopu 2	0.286	0.248	1.155	0.248
Kakabeak 1	0.335	0.233	1.441	0.150
Kakabeak 2	0.112	0.251	0.446	0.655
Green Gecko 1	0.190	0.246	0.771	0.441
Green Gecko 2	0.549	0.241	2.278	0.023
Bush Falcon 1	0.550	0.253	2.174	0.030
Bush Falcon 2	0.706	0.246	2.865	0.004
Cost	-0.021	0.004	-5.136	<0.001
Indicator for Status Quo	0.876	0.413	2.122	0.034
Log-likelihood value				-324.473
Pseudo Rho^2				0.078
Adj Pseudo Rho^2				0.060
Number of choice observations				314
Number of respondents				35

Covering letter